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Adsorption of Cu Metal and Colorant using *Moringa olifera* Seed as Adsorbent

[1]Ruslan Shamsuddeen, *[2]Alhassan M. Garba, [3]Fa'iz A. Sheshe, [4]Dalhatu A. Abdullahi

[1] Department of Chemical Science, Federal University Wukari, P.M.B. 1020, Taraba State, Nigeria.
Email: ruslanshamsuddeen@gmail.com

[2 & 4] Department of Chemistry, Mewar University. NH – 79. Gangrar, Chittorgarh, Rajasthan 312901 India.Email: alhassangarba01@gmail.com [2] / dalhatuaa8@gmail.com [4]

ORCI ID: https://orcid.org/0000-0001-5608-0722 [2]

[3] Department of Chemistry, Kano University of Science and Technology Wudil, P.M.B 3244, Kano State, Nigeria.
Email: faizsheshe@yahoo.com

[*]Correspondence Email:- alhassangarba01@gmail.com

+2348062228098 / +2348069042119

ABSTRACT

Moringa oliefera seed is a multipurpose tree with most of its parts being useful for a number of applications. This study is carried out to investigate the potential of *Moringa oliefera* seed to be used as biosorbent for Cu metal and colorants from water system as a natural environmentally friendly biosorbent. The water was contaminated by dissolving definite amount of copper sulphate and used to in the study to monitor efficiency of the adsorption of copper by seed of *Moringa olifera*, and the dye solution (Methyl red) was also prepared by dissolving definite of amount of the dye and used to monitor the colour adsorption property of the seed of *Moringa olifera*. The results of copper adsorption from contaminated water showed that *Moringa oliefera* seed could be a promising adsorbent for copper from the water system with highest efficiency at pH of 7, 90 minutes' contact time and 165 rpm, the results of colour adsorption show that the percentage of adsorption increases as the amount of the adsorbent (*Moringa olifera)* increased. The absorbance of the Cu metal solution and dye solution were analysed by Atomic Absorption Spectra machines (AAS) and Uv-vis spectrophotometer respectively.

Key words: - *Adsorption, Copper metal, colorant, Adsorbent*

INTRODUCTION

Heavy metals are commonly released in the waste water from various industries. electroplating and surface treatment practices leads creation of considerable quantities of waste water containing heavy metals (such as cadmium, zinc, lead, chromium, nickel, copper, vanadium, platinum, silver and titanium). Apart from this waste water from leather, textile, pigment and dyes, paint, wood processing, petroleum refining industries and photographic firm production contain significant amount of heavy metals these heavy metal ions are toxic to both human and animals. The toxic metals cause physical discomfort and sometimes life-threatening illness and irreversible damage to vital body system [1].

Adsorption techniques for wastewater treatment have become more popular in recent years owing to their efficiency in the removal of pollutants too stable for biological methods. Adsorption can produce high quality water while also being a process that is economically feasible [2]. Decolourisation is a result of two mechanism-adsorption and exchange. And is influenced by many factors including dye/sorbent interaction, sorbent surface area, particle size, temperature, pH and contact time [3].

Moringa Oliefera seeds can be considered as a natural adsorbent material that presents some important characteristics in relation to its application in effluent treatment. These seeds have been used for the treatment of turbid water due to their flocculation properties [4].

MATERIAL AND METHOD

Materials

The pod of Moringa *oleifera* was collected from around Gabasawa local government Area of Kano state. All the chemicals and reagents used are of analytical grade obtained from department of chemistry laboratory Kano University of Science and Technology, Wudil and Kano state Water Board Laboratory, Challawa. The absorbance of Cu metal was measured by Atomic Absorption Spectrometer (AAS) and the Absorbance of colour was determined by UV-Vis Spectrophotometer [5].

Preparation of Adsorbent (*Moringa olifera* seed)

The collected pod of *Moringa olifere* was dried under room temperature for a period of one week, the pod was broken to exposed the winged coated seeds, the exposed winged coated seed was left for 24 hours to complete drying, the dried coated seeds were crushed using mortar and pestle. The broken seed coat and wings were blown off by the aid of gravitation and wind, the bare seeds were obtained. The bare seeds were then ground using electric blending machine until a very fine powder of the grounded seeds were obtained, the grounded and sieved powder of the seed was stored in an air tight container [6].

Preparation of Cu (II) solution

The solutions were self-contaminated by dissolving 3.93 g of Copper (II) sulphate in 1000 ml of deionized water making it to be 1000ppm (stock solution). From the stock solution 5ppm was prepared by adding 20 ml of the stock solution in to 250 ml reagent bottle and making it up to the mark by adding deionized water [6].

Preparation of dye solution

Two different concentration of dye solution were prepared by dissolving 1 g and 2 g of methyl red in 1000ml of distilled water each. The experimental solution was prepared by taking 250 ml of each of the solutions to get the desired concentration. The solutions were divided in to four each (250ml) [7] with slight modification.

Experimental procedure for Cu Adsorption

100 ml of Cu (II) sulphate solution 5ppm in (250 ml) conical flask were prepared, the pH of the solutions was adjusted using 0.1M HCL and NaOH solutions, such that the solutions had a pH of 5, 6 and 7. The flasks were labeled with respect to their pH. 0.1 g of the adsorbent (*Moringa olifera*) was added to each conical flask containing different pH of Cu (II) sulphate solution and the mixture was subjected to a shaker with contact time of 60 and 90 minutes and 100 and 165 rpm at room temperature. The solutions were filtered using whatmann filter paper 1 and observed the absorbance of metal using AAS [6].

Experimental procedure for Dye Adsorption

Two different prepared dye solutions of 1 g and 2 g are added in to four different beakers each containing 1, 2, 3 and 4 g of the adsorbent (*Moringa olifera* seed), and the mixture was subjected in to the shaker with a contact time of 10 minutes at room temperature. The absorbance of the solutions mixture was measured using UV–vis spectrophotometer at 280 and 320 nm [8] with slight modification.

RESULT

Cu Adsorption

The results of copper adsorption from water showed that *Moringa oliefera* seed could be a promising adsorbent for copper from the water system with higher efficiency at pH of 7. Table 1 shows the various absorbance of Cu adsorption at different pH of 5, 6 and 7.

Table 1.Results of the various adsorption of Cu at different parameters of pH, agitation and contact time

pH	Absorbance (nm)	Concentration (µg/ml)	RPM	Contact time (min)
5	0.0201	53.623	100	60
5	0.0326	85.878	100	90
5	0.0034	14.653	165	60
5	0.0082	21.712	165	90
6	0.0120	31.206	100	60
6	0.0134	48.409	100	90
6	0.0086	15.132	165	60
6	0.0101	26.529	165	90
7	0.0138	41.756	100	60
7	0.0203	54.601	100	90
7	0.0088	22.732	165	60
7	0.0128	35.300	165	90

Colour Adsorption

The results of the absorbance from the UV-vis spectrophotometer shows the amount of colour removed by the adsorbent (*Moringa olifera* seed). Table 2 show the various result of absorbance of adsorption of colour by adsorbent (*Moringa olifera* seed) and absorbance of colour without adsorbent stand as control (Cont) for both 1 g/L and 2 g/L solutions of the colorant.

Table 2. Results of colour adsorption using Moringa olifera seed as adsorbent for various dye concentration at different wavelength.

Adsorbent (g)	Colorant (g/L)	Wavelength (nm)	Absorbance (nm)	% of Adsorption (%)
1	1	280	1.530	43.08
2	1	280	1.521	43.42
3	1	280	1.509	43.86
4	1	280	1.501	44.16
Cont	1	280	[1]2.688	-
1	2	320	2.531	32.38
2	2	320	2.526	32.51
3	2	320	2.519	32.70
4	2	320	2.510	32.94
Cont	2	320	[2]3.743	-

DISCUSSION

Figure 1. Show the absorbance of Cu by *Moringa olifera* at 60 minutes' contact time and 100 and 165 rpm. Figure 2 shows the absorbance of Cu by *Moringa olifera* at 90 minuet contact time and 100 and 165rpm.

Effect of pH on Cu adsorption

It was observed that at the higher pH values the absorbance is high as compared to that of lower pH values, this could be because at the lower pH values (acidic medium) the adsorption could have disrupted due to competitive interactions between the heavy metal ions and the hydrogen ions from acidic medium, which restricts or lower the adsorption whereas at higher pH values like 7 (neutral) the adsorption is higher as there is no competition as the hydrogen ions are neutralized figure 3.

Effect of agitation on Cu adsorption

Agitation is very important as it increase the efficiency of absorbance and it helps speeding up the process. It was observed that the best absorbance was found at 165 rpm figure 3. At low rpm the matter might accumulate at the bottom of the flask.

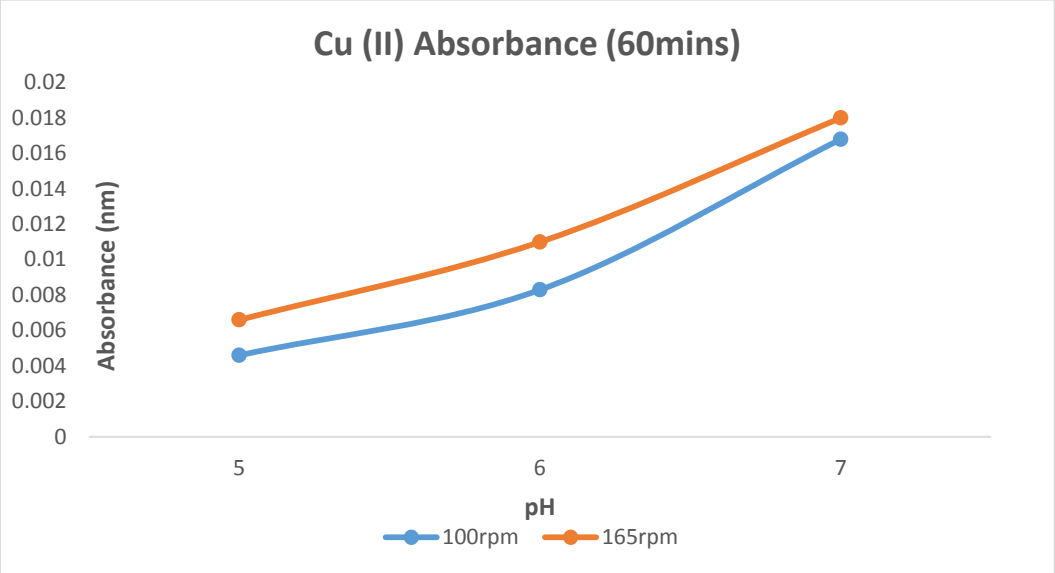

Figure 1. Absorbance of Cu by Moringa olifera at 60 minutes' contact time and 100 and 165 rpm.

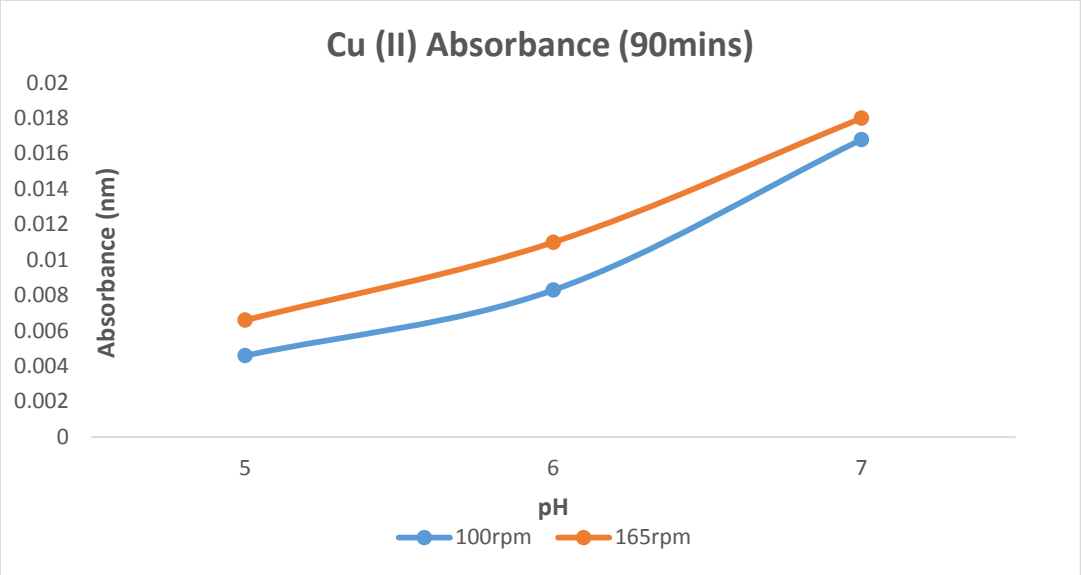

Figure 2. Absorbance of Cu by Moringa olifera at 90 minutes' contact time and 100 and 165 rpm.

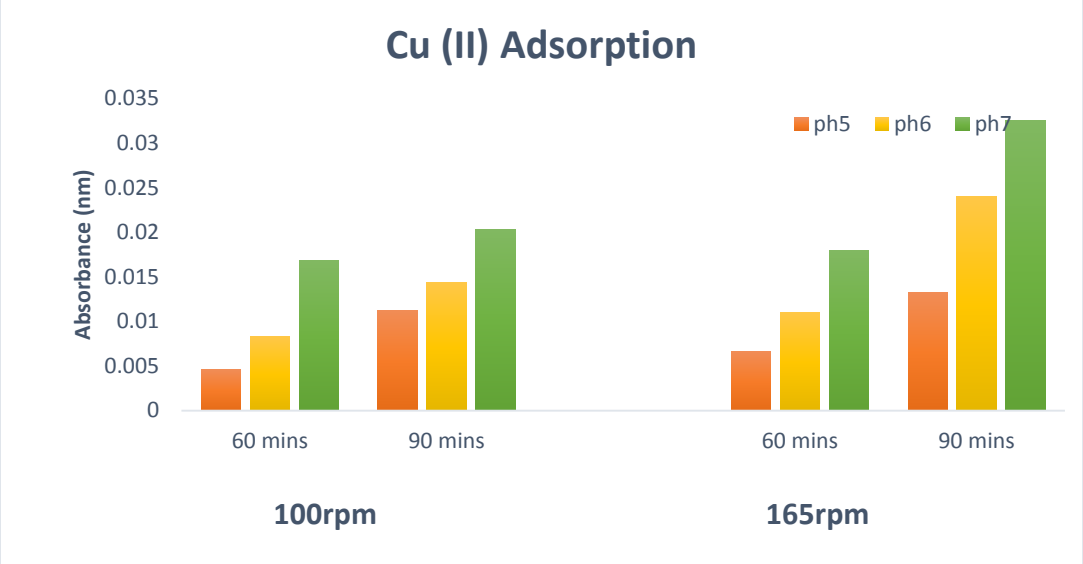

Figure 3. Adsorption of Cu metal at various, pH, contact time and different rpm value

Colour Adsorption

Effect of the amount of Adsorbent.

The amount of Adsorbent (*Moringa olifera)* used in the study was from 1 to 4 g. Figure 4 & 5 show the variation of absorbance of the solution as the amount of adsorbent increases for 1 g/L figure 4 and 2 g/L figure 5 methyl red solution respectively. The results show that the percentage of adsorption increases as the amount of the adsorbent (*Moringa olifera)* increased figure 6. It is apparent that by increasing the amount of the adsorbent, the number of sorption sites available for sorbent-biosolute interaction is increased, thereby resulting in the increased percentage of colour adsorption from the solution. The decrease in adsorbent capacity, (the amount of dye sorbed per unit weight of adsorbent) with increase amount adsorbent may be attributed due to two reasons.

The increase in amount of adsorbent at constant dye concentration and volume will lead to unsaturation of sorption sites through the sorption process and secondly may be due to particulate interaction such as aggregation resulting from high amount of adsorbent. Such aggregation would lead to a decrease in total surface area of the adsorbent and an increase in diffusional path length [9].

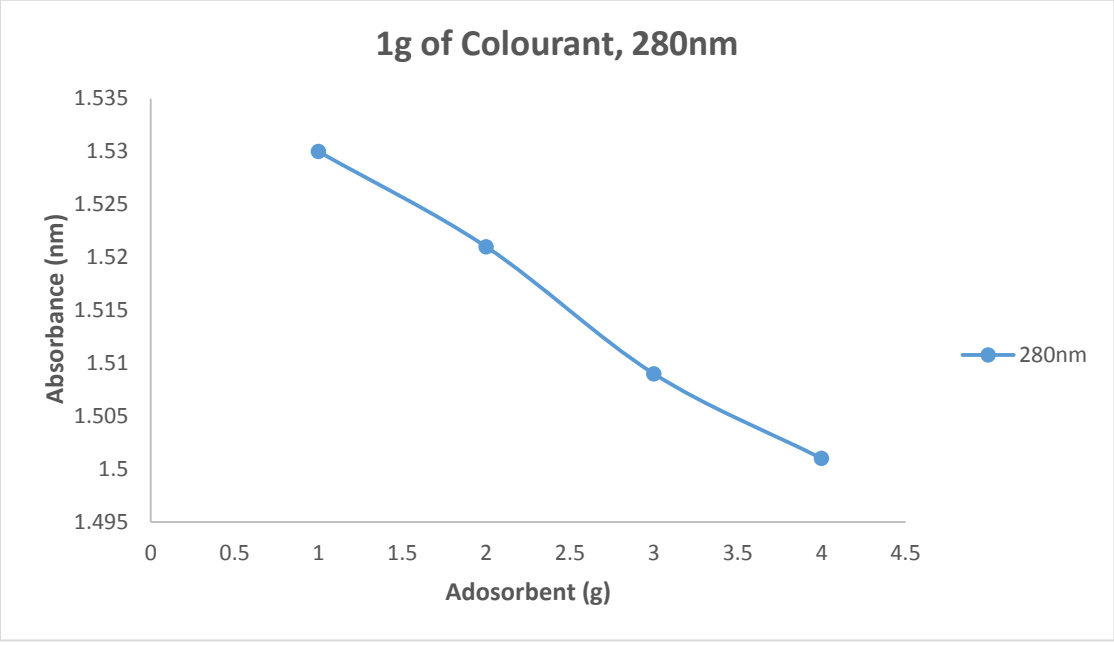

Figure 4. Variation of the absorbance of colour adsorption at 1 g of colorant and 280nm

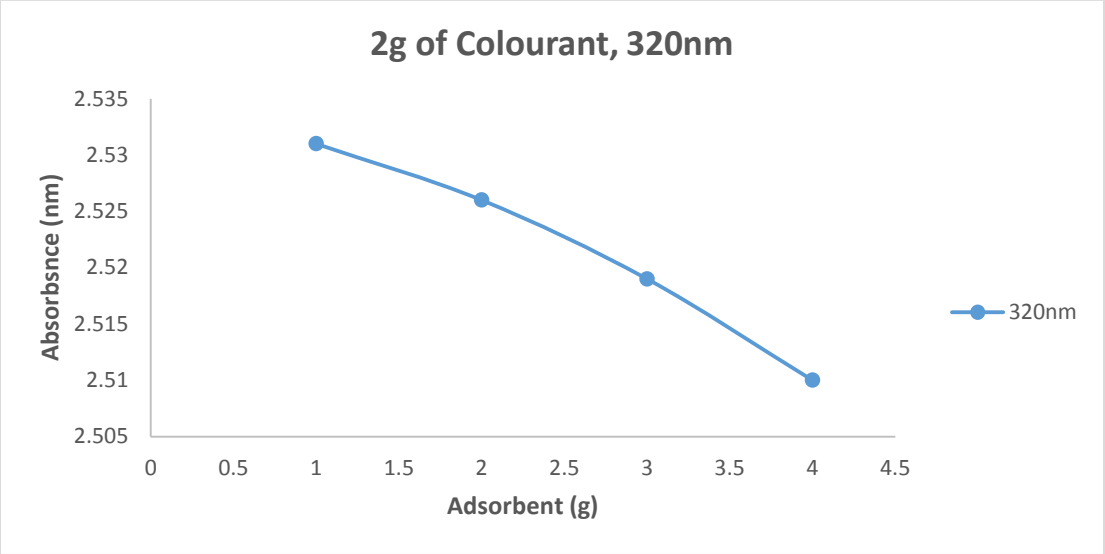

Figure 5. Variation of the absorbance of colour adsorption at 2 g of colorant and 320nm

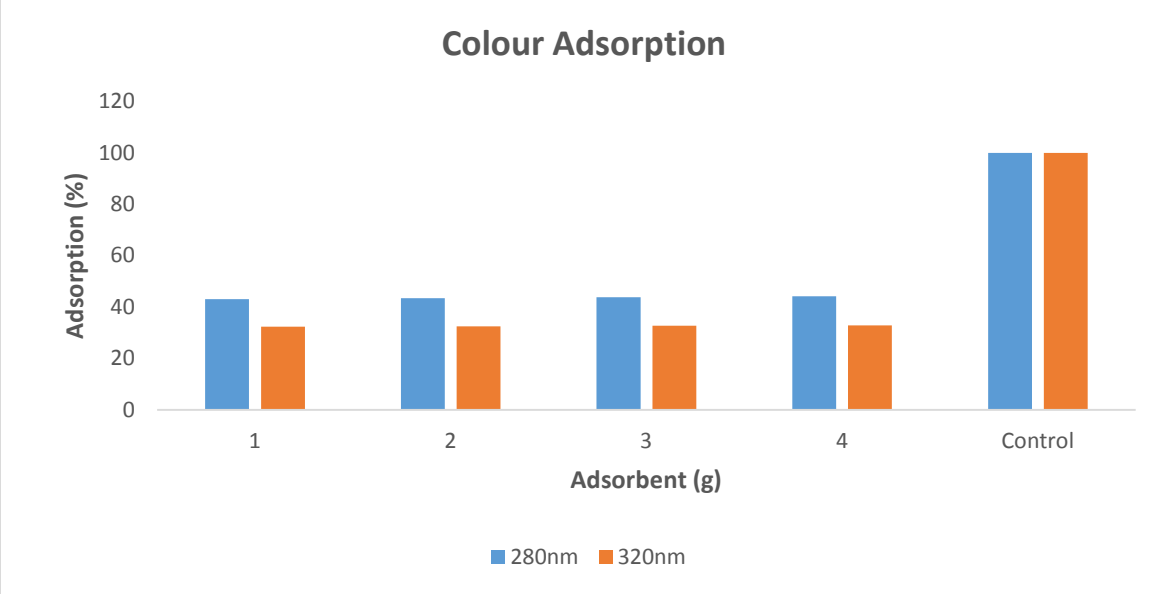

Figure 6. Percentage of colour adsorption by Moringa olifera at 280 and 320 nm

Conclusion

The adsorption Cu metal using *Moringa olifera* seed as adsorbents was carried out using various parameters such as different contact time, agitation speed and pH values. The overall best result from Cu metal adsorption using *Moringa olifera* seed as adsorbent was obtained at pH of 7, 165 rpm and 90 minutes' contacts time and for colour adsorption the best result was obtained at 280 nm for all various weight of adsorbent used. The particles size of the adsorbent was very small hence and helped in the efficiency of the adsorption. This study also proved that the plant *Moringa olifera* seed has adsorption property apart of biological activities, the plants also are economical due to the high availability of the plant and the process is ecofriendly as it does not cause any harm to the environment.

The result of this study showed that *Moringa oliefera* seed can be used for cu (II) and color removal from water systems and as coagulant to remove turbidity from water and the adsorption technique is suitable process for treatment of effluent from dyeing industry.

Further study should be done on the process to improve the efficiency of the process and modify the experimental procedure by decreasing the particle size to Nano particles to achieve better efficiency. Also, chemical modifications may be imposed on the seed of the plant to increase the absorbance capacity.

Conflict of Interest

there is no conflict of interest.

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